

Fertility and Analogy in Pacific Palaeodemography



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THE RECONSTRUCTION of the demography of prehistoric Pacific island populations has received sustained scholarly attention over the last several years (e.g., Brewis, Molloy, and Sutton 1990; Clark 1988; Green 1993; Kirch 1984; Stan- nard 1989; Sutton 1986). This stems from the recognition that an improved understanding of palaeodemography provides important insights into technological, sociocultural, biological, and ecological transformation and evolution. For example, it has long been recognized that the specific Polynesian (pre)history of shared genetic ancestry with subsequent dispersal, semi-isolation, and divergence of populations provides an almost unequalled opportunity for examining evolutionary change in homologous biological, linguistic, and social systems (e.g., Kirch and Green 1987). An understanding of gross-level patterns of population structure and parameters is essential to an interpretation of the direction, style, tempo, cause, and results of these evolutionary/transformational changes.

This realization is clearly expressed in the now classic palaeodemographic analysis of Kirch (1984). In investigating the evolution of the Polynesian chiefdoms, Kirch based some central components of his model building on precontact skeletal age-at-death distributions. Subsequently, a growing consideration of the problems inherent to palaeodemographic reconstruction based on skeletal series has emerged. For example, Sutton and Molloy (1989) and Underwood (1989a) discuss a range of limitations inherent to the process of linking skeletal age-at-death distributions in meaningful ways to the populations from which they derive. Even more recently, improved understanding of the nature of heterogeneity in distributions of frailty (risk of morbidity and mortality) within populations has provided another example of the hazards of skeletal palaeodemographic interpretation (Wood, Milner, Harpending, and Weiss 1992).¹ And, frustratingly, it even now appears that mis-aging of age-at-death distributions may be inherent even in reference series themselves (Konigsberg and Frankenberg 1992).

These seemingly insurmountable criticisms (cf. Goodman 1993) of skeletal palaeodemography need not hamper the development of an active and insightful Pacific palaeodemography, although they necessarily spur changes in direction and emphasis. There are other possible avenues for investigation of the nature of precontact population dynamics in the island environment, particularly since the region is rich in the records of ethnography, ethnohistory, oral tradition, archae-

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ology, and human biology. Although the notion of a nonskeletal palaeodemography has the sense of the oxymoronic, this paper makes the argument that the use of analogies (or homologies) of early historic and contemporary Pacific island populations is one way to achieve an improved understanding of the dynamics and structures of Pacific palaeopopulations.²

The use of analogy in Pacific palaeodemography is not novel. Kirch drew on two Polynesian analogies in his reconstructions, selecting eighteenth-century Pitcairn as the extreme example of a rapidly expanding population (1984:102) and nineteenth-century Tikopia as an extended analogy for a late sequence dense "regulated" population (1984:116–120). Sutton and Molloy (1989:32) take issue with Kirch's "misuse of special cases," arguing on the basis of anomalies in age distributions, fertility levels, technology, and so on, that these examples "should not be overused in the construction of models of past Polynesian demography." This paper argues that, if anything, such analogies have been underused, but should rather be applied in different ways.

Here I focus on the key issue of the relationship between historic and prehistoric population dynamics, assessing how they share important structural and dynamic demographic features: similarities that allow analogues to be reasonably applied. Although (and it cannot be overemphasized) the demographic history and context of each island and archipelago were unique in detail and influenced strongly by different social climates, ecological parameters, and contingencies of history, many of the demographic challenges of island life within that same island setting transcend pre-Contact and historic periods. Structural similarities allow analogies to be drawn (backwards). There has been a lack of active interest in linking contemporary and historic population scenarios with the archaeological record in the Pacific literature. I would argue that this flows from the implicit notion that historic contexts of population were fundamentally different from prehistoric ones, and so essentially irrelevant to them. Specifically, prehistoric populations transformed on a trajectory toward stable growth and ultimately to stasis, whereas historic populations collapsed, often dramatically, and then (usually) recovered. (These various generic population growth and collapse scenarios are recreated in Figure 1.) The two processes are seen as having separate ecological engagements, different disease and sociocultural contexts, and fundamentally different patterns and outcomes.

The growth-toward-stasis model of Kirch (1984) is an example of this model of pre-Contact population change in (Polynesian) island sequences. He poses:

a relatively high intrinsic rate of population increase would have been essential to a successful strategy of island colonization, and indeed, that rapid population growth helped to assure a propagule's permanence. . . . At the same time, it is clear that the exponential rates of population growth which characterized early phases of settlement on Polynesian islands were not generally operative when the European explorers arrived on the scene, one or more millennia later . . . in which a variety of cultural and natural mechanisms served to maintain island populations at essentially static levels. . . . Thus, while initial population growth rates were high, a balance between human numbers and the capacity of their insular environments to maintain them had to be reached. (Kirch 1984:96)

At a general level, Kirch (1984:102) favors a sigmoidal population trajectory on the basis of archaeological data, although he presents a number of ways this

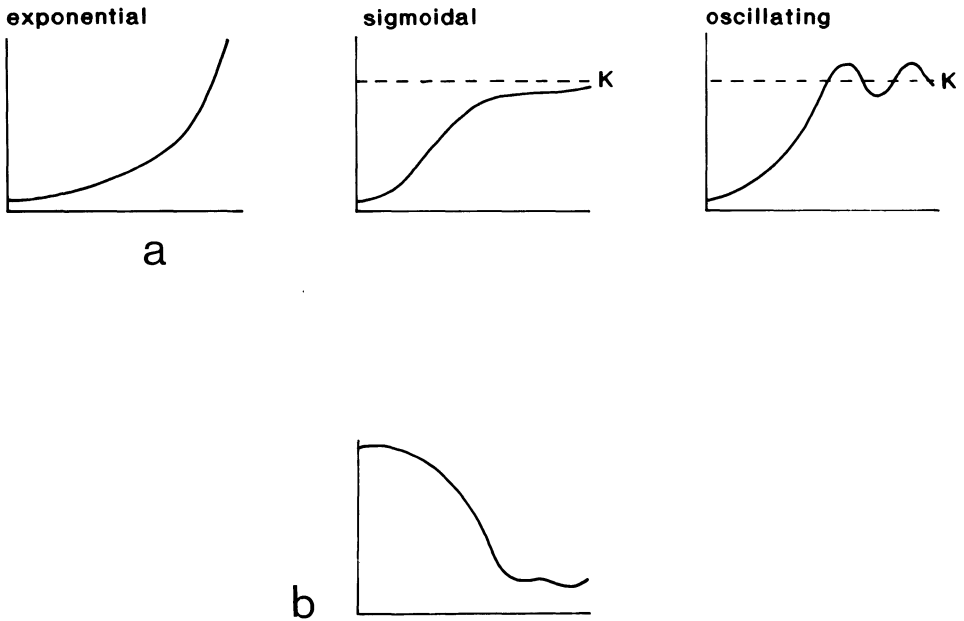


Fig. 1. Population change scenarios. *a*, hypothetical population change (growth) trajectories (adapted from Kirch 1994:102). *b*, stylized example of population collapse, Guam A.D. 1650–1800 (adapted from figures in Underwood 1973).

could be realized. Details of this model have been contested on several points (Clark 1988; Stannard 1989; Sutton and Molloy 1989); however, it appears that the very general outlines of the model—of a trend toward stable growth modified substantially at points where resource limits are approached—have been well accepted in Pacific archaeology. For example, in a recent review of the evidence, Green (1993) favors an oscillating model that maintains a predominantly sigmoidal shape.³

The focus on the stable-growth-toward-stasis scenario has deflected attention from the understanding that Pacific island palaeopopulations experienced regular numerical flux. Pacific island existence is, by its very nature, often precarious—whether population is dense or not. All types of Pacific island environments, for example, are subject variously to the threats of cyclones and droughts (Bayliss-Smith et al. 1988; McArthur 1967:294; Vayda 1959). For example, 20 percent of the population died in a single famine on Kapingamarangi in 1916–1917 (Wiens 1962:158), and the genetic evidence of extremely high mortality after a typhoon in the mid-1800s remains in the populations of Mokil and Pingelap (Morton et al. 1973). Specific aspects of Pacific social systematics can be interpreted as being adapted to problems of regular flux. For example, interisland ties of contact and reciprocity are important in reducing risks of extinction in Micronesian groups (Alkire 1965; Williamson and Sabath 1984). Schneider (1957) goes so far to argue that Yapese emotional responses to typhoon disaster were unlike the “disaster syndrome” seen in other groups and maintains they exemplify an adaptive emotional coping mechanism in dealing regularly with catastrophe.

Populations that respond demographically, virtually on a year-to-year basis, to

the perturbations of island life would tend ultimately to express a pattern of success: growth, increased density, and the flexibility to support population expansion, intensification, and further colonization, while hedging against the stochastic risk of extinction (Black 1978; McArthur et al. 1976). But this growth need not be essentially stable in nature (see Taeuber 1961), compared for example with the tendency toward homeostatic equilibrium and stationarity seen in (and adaptive for) highland Papua New Guinea populations (Wood 1980).

One implication of perceiving population in a more or less constant state of numerical flux, but with an overall tendency to growth, overcoming threats of depopulation as well as overpopulation, makes it easier to draw lines of continuity in reproductive strategy. Many Pacific island populations underwent a series of dramatic drops in numerical size and alterations in age/sex structure in the last several centuries, particularly as a result of introduced infectious diseases, labor recruitment, and warfare (McArthur 1967). Given that these insults often occurred simultaneously in the early historic period, and considering the massive level of depopulation in some areas, it is remarkable that by the early twentieth century many populations in the Pacific region had begun to show signs of demographic recovery. (To cite but one example, the population of Yap had declined to seven percent of its estimated pre-Contact size by World War II [Hagaman 1974]). Although this may in part reflect global trends in declining mortality and increasing fertility—the so-called second phase of the demographic transition (e.g., Taylor et al. 1989)—it also reflects that the reproductive repertoires of these populations provided the means to allow recovery from demographic catastrophe in many locations. The strategies that allowed these populations to recover in the historic period are the types of adaptations that populations would have accrued in proving reproductively successful in prehistoric settings of demographic perturbation (i.e., resisting extinction and expanding). The ramifications of this are exemplified in Underwood's (1989*a*; see also 1990*a*) conclusions about changes in the population structure of Nauru over the course of this century. She describes:

an "atoll-type model" to sketch out broad outlines of the probable population history of Nauru in the pre-Contact period. In brief, this model envisages the post-settlement period as characterized by episodes of rapid population growth, interspersed with interludes of sudden declines occasioned by the effects of the sporadic droughts which periodically wrack the island, and, perhaps too, in consequence of outbreaks of warfare. (Underwood 1989*a*:6)

This suggests "a pre-Contact history of long term post-settlement population increase, despite episodic declines, resulting from persistently high levels of fertility, generally low or moderate death rates, and balanced mainly by the demographic consequences of occasional migrations, whether forced or voluntary."

FERTILITY ANALOGUES

If structural similarities extend across the prehistoric/historic divide, this begs the question, what are good analogies? Recently, Molloy and Huntsman (in press) have suggested that post-collapse nineteenth-century Tokelau may be comparable in structurally meaningful ways to a small but rapidly growing pre-Contact settler population. There are other possible analogue scenarios. In exploring these,

the focus here is on fertility parameters, because large transformations in population numbers in prehistoric sequences were more likely to result from fertility transformations than mortality ones (Sutton and Molloy 1989). The discussion that follows rests on the observation that variance in fertility across time and space in the Pacific setting most broadly represents the manifestation of differences in reproductive behavior and disease, so these two aspects of fertility are highlighted. With a view to demonstrating the range of expressions of fertility in the historic Pacific setting, historical and rural contemporary case studies that may be applicable as analogues were located. Being circumspect about which population cases to include, I used the following criteria to limit the list to the better documented cases with more reliable and comparable data sets:

1. Data collection is based on anthropological census taking—being either representative reproductive history interviewing or ethnographically informed demographic survey, with effort to locate possible biases, or extensive historical demographic reconstruction based on linkage or family reconstitution.⁴

2. For case studies based on cohort data (such as reproductive histories), sample size of postmenopausal women exceeds 45, or represents *all* reproductive age women on the island.⁵ If based on period measures, samples represent 200 or more postmenopausal women.

3. Demographic analyses provide an estimate of completed family size (CFS) or provide data descriptions that make its calculation possible. CFS is a robust index measure of fertility levels, calculated as mean number of live births to women at or beyond a specified mature age.

4. The groups have low or nil use rates of biomedical contraceptives. That is, they must conform to the “natural fertility” rubric, following the definition of Wood (1990:212).

5. Two separate studies of the same population are included if they sampled in separate time periods.

A list of population studies located in the literature fitting these criteria is presented in Table 1.⁶ Studies based on anthropological census are dated by the year in which data was collected, so completed family size refers to the preceding, not current, cohorts of women of reproductive age. For studies based on registration data, the dates refer to the period covered by analysis, and the measures thus refer to the fertility of women reproducing in that period. Specific note is made if CFS and primary infertility measures are for all marital statuses or only for ever-married women. Measures based on married women only are preferentially selected, as the measure more closely approximates one for only susceptible women (i.e., exposed to risk of pregnancy). As studies differ in ages from which CFS is calculated, the minimum age of women included in each sample is specified in Table 1. If possible, figures for women over 45 are selected or recalculated from aggregate data. If this could not be achieved, measures over 40 are assumed to be very comparable to those over 45, as only a small proportion of women would be expected to have live births after age 40 (see Brewis 1993a for this specific argument).

The measures of CFS for all women (CFS_{all}—which includes women who never had a live birth) and primary infertility levels (proportion of women who fail to produce any live births by the end of their reproductive spans) for each of these cases are presented in Table 2. The distribution of primary infertility rates

TABLE 1. FERTILITY STUDIES IN PACIFIC ISLAND POPULATIONS

| POPULATION | DATES | DATA FORM | SAMPLE SIZE | MINIMUM AGE OF WOMEN | EVER-MARRIED ONLY? | SOURCES |
|--------------------|-----------|---|----------------|-------------------------|-----------------------|---|
| Yap I | 1946–1947 | Reproductive histories | 262 | 26 | n | Hunt et al. 1949 |
| Yap II | 1966 | Anthropological census | 221 | 45 | n | Underwood 1973 |
| Ulithi I | 1949 | Anthropological census | 96 | 45 | n | Lessa and Myers 1962 |
| Ulithi II | 1960 | Anthropological census | 86 | 45 | n | Lessa and Myers 1962 |
| Eauripik | 1973 | Reproductive histories | 11 | 45 | n | Levin 1978 |
| Pingelap I | 1870–1919 | Genealogical reconstruction | 365 | ? | n | Damas 1983 |
| Pingelap II | 1920–1944 | Genealogical reconstruction | 191 | ? | n | Damas 1983 |
| Guam | 1901–1941 | Registration-based linkages | 1181 | 40 | y | Underwood 1989 <i>b</i> , 1990 <i>b</i> |
| Kosrae–Utwe | 1880–1929 | Genealogical reconstruction | 49 | 45 | n | Ritter 1978 |
| Kosrae–Malem | 1880–1929 | Genealogical reconstruction | 90 | 45 | n | Ritter 1978 |
| Namoluk | 1971 | Anthropological census | 41 | 45 | y | Marshall 1975 |
| Majuro | 1984 | Family-planning survey | 72 | 40–49 only | n | Levy et al. 1988 |
| Ebeye | 1984 | Family-planning survey | 76 | 40–49 only | n | Levy et al. 1988 |
| Makin | 1972 | Anthropological census | 92 | 45 | n | Lambert 1975 |
| Butaritari | 1990 | Anthropological census | 239 | 45 | y | Brewis 1992 |
| Tokelau I | 1800s | Registration and genealogies | 49 | ? | n | Molloy and Huntsman 1993 |
| Tokelau II | 1971 | Anthropological census | 152 | 45 | n | Hooper and Huntsman 1973 |
| Mangaia | 1958 | Anthropological census | 61 | 45 | n | Marshall 1971 |
| Cook Islands | 1956 | Census analysis | 1066 | 45 | n | McArthur 1967:223–224 |
| Marquesas | 1881 | Reproductive histories | 47 | 45 | n | McArthur 1967; Clavel 1884 |
| Pitcairn | 1790–1856 | Vital registration | ? | ? | ? | Refshauge and Walsh 1981 |
| American Samoa | 1956 | Census analysis | ?(large) | 45 | n | McArthur 1967:157–158 |
| Melanesian Fijians | 1956 | Census analysis | ?(large) | 40–49 only | n | McArthur 1967:61 |
| Nukuoro | 1965 | Anthropological census | 69 | 45 | y | Carroll 1975 |
| Ontong Java | 1972 | Anthropological census | (whole island) | 45 | n | Bayliss-Smith 1975 |
| Outer Reef Islands | 1960 | Anthropological census | 34 | 45 | n | Davenport 1975 |
| Buka I | 1948–1953 | Medical survey | 51 | 45 | n | Scragg 1957 |
| Buka II | 1967 | Anthropological census | 103 | ? | ? | Ring and Scragg 1973 |
| Tigak | 1948–1953 | Medical survey | 47 | 45 | n | Scragg 1957 |
| Tabar | 1948–1953 | Medical survey | 137 | 45 | n | Scragg 1957 |
| Lesu | 1929 | Anthropological census and genealogies | 295 | 40 | y | Powdermaker 1931 |
| Karkar | 1968 | Anthropological census | 234 | 45 | y | Stanhope and Hornabrook 1974 |
| New Ireland I | 1965 | Anthropological census | 258 | 45 | n | Ring and Scragg 1973 |
| New Ireland II | 1976 | Anthropological census | 70 | 45 | n | Young 1987 |

TABLE 2. FERTILITY MEASURES AND DISEASE PRESENCE IN PACIFIC ISLAND POPULATION STUDIES

| POPULATION | LEVEL OF GONORRHOEA | MALARIA PRESENT? | CFS _{all} | CFS _{fertile} | PERCENTAGE OF WOMEN PRIMARILY INFERTILE |
|-----------------------|------------------------|---------------------|--------------------|------------------------|--|
| Yap I | Prevalent | n | 2.50 | — | 72.90? |
| Yap II | Prevalent | n | 2.02 | 8.79 | 36.70 |
| Ulithi I | Prevalent | n | 1.05 | 2.53 | 58.33 |
| Uithi II | Prevalent | n | 1.69 | 3.37 | 50.00 |
| Eauripik | Present | n | 5.0 | 4.5 | 7.69 |
| Pingelap I | Prevalent | n | 2.66 | 3.47 | 23.29 |
| Pingelap II | Present | n | 4.14 | 4.74 | 12.60 |
| Kosrae—Utwē | Negligible | n | 8.29 | 8.64 | 4.08 |
| Kosrae—Malem | Negligible | n | 7.22 | 7.93 | 8.89 |
| Guam | Negligible | n | 7.70 | 8.20 | 6.10 |
| Namoluk | Negligible | n | 4.58 | 5.08 | 9.76 |
| Majuro | Negligible | n | 7.10 | 7.74 | 8.33 |
| Ebeye | Negligible | n | 8.13 | 8.24 | 1.32 |
| Makin | Negligible | n | 6.35 | 7.36 | 13.00 |
| Butaritari | Negligible | n | 7.13 | 7.22 | 1.29 |
| Tokelau I | Negligible | n | 6.20 | — | 12.50 |
| Tokelau II | Negligible | n | 4.90 | 5.84 | 11.18 |
| Mangaia | Present | n | 5.72 | 6.98 | 18.00 |
| Cook Islands | Present- negligible | n | 6.42 | 7.99 | 19.60 |
| Marquesas | Prevalent | n | 4.23 | 7.37 | 42.60 |
| Pitcairn | Negligible | n | 11.45 | — | 0.00? |
| American Samoa | Negligible | n | 6.26 | 13.56 | 7.24 |
| Melanesian Fijians | Negligible | n | 4.78 | 5.39 | 11.29 |
| Nukuoro | Present | n | 3.11 | 5.22 | 40.50 |
| Ontong Java | Negligible | y | 6.28 | — | — |
| Outer Reef Islands | Negligible | y | 4.74 | 5.56 | 11.76 |
| Buka I | Present | y | 5.96 | 6.47 | 7.84 |
| Buka II | Negligible | y | 8.68 | — | — |
| Tigak | Prevalent | y | 4.34 | 5.23 | 17.02 |
| Tabar | Prevalent | y | 2.92 | 3.96 | 26.28 |
| Lesu | Prevalent | y | 2.60 | 2.98 | 11.86 |
| Karkar | Negligible | y | 6.35 | — | <3.80 |
| New Ireland I | Prevalent | y | 3.34 | — | 40.00 |
| New Ireland II | Present | y | 5.36 | — | — |

and CFS_{all} for the sample of Pacific island populations is plotted in Figure 2, and shows how closely connected the two measures are. Completed family size for women who had at least one birth, expressed as CFS_{fertile}, is also presented in Table 2, if possible to estimate. This measure is a reasonably robust index of the level of secondary infertility (onset of infertility after at least one birth has been achieved) in a group.

A lower CFS_{fertile} roughly indexes a higher level of secondary infertility (failure to ever bear a child), especially when it is associated with a low rate of primary infertility. This combination often expresses population exposure to the infertility

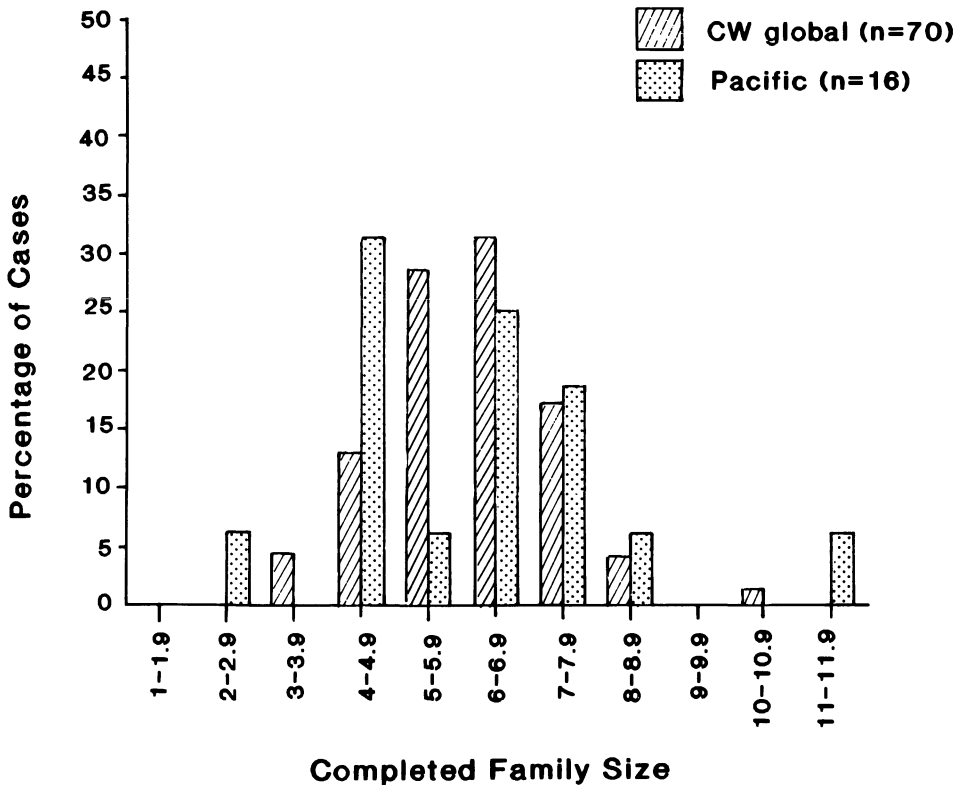


Fig. 3. Completed family size in the Pacific sample compared to Campbell and Wood's (1988) global sample.

ural fertility" populations from a global selection of varied cultural and ecological milieu (hereafter the "CW global" sample) is shown with the Pacific sample.⁹

DISEASE AND FERTILITY IN PREHISTORY

If there is a single factor that can be pointed to as being key to any ecodemographic transformation of Pacific populations after contact with Europeans, it is exposure to novel disease. Although there have been some sophisticated discussions of the role of such diseases in historic fertility change (e.g., Underwood 1973), the impact of disease on pre-Contact Pacific fertility has been essentially ignored. Several endemic diseases of the pre-Contact island Pacific were fertility-inhibiting; the essential trio are malaria, hookworm, and filariasis. All three are parasitic and so could, and often did, accompany colonists on settlement voyages out across the region.

Malaria

Malaria was endemic in the pre-Contact period but essentially confined to near Oceania (Melanesia). Near Oceanic populations are variously classified as holo-,

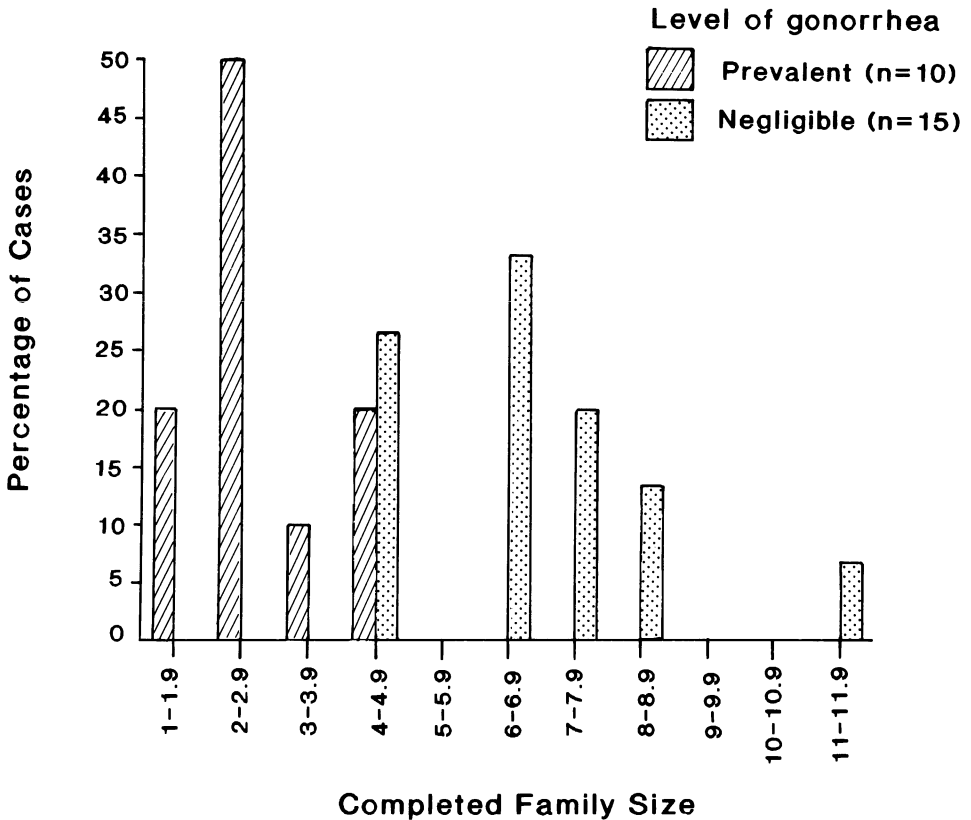


Fig. 4. Completed family size in Pacific island populations heavily or negligibly infected by untreated gonorrhea.

meso-, and hyperendemic. For example, much of the Solomon Islands is mesoendemic, while parts of New Britain are hyperendemic (Cattani et al. 1985). The disease most specifically affects fertility by precipitating fetal death from episodes of maternal high fever. Pregnant women are especially at risk of malarial morbidity and mortality, apparently because of impaired maternal antibody production during pregnancy (Prasad et al. 1990). Malaria can certainly lower population-level fertility, at least to the degree that eradication of malaria can spur rapid population growth (Brown 1987). Importantly, it appears that the health risk of malaria is only substantial for women and their fetuses in mesoendemic areas, where first onset of fever is often delayed until adulthood; hyperimmunity seems to provide some protection for women in hyperendemic areas (Lawson 1967). (Groube 1993 provides an important focusing discussion of malarial mortality in Pacific prehistory.)

Helminthic Infection

Pre-Contact populations throughout the Pacific were infected, probably heavily, with helminthic infections, such as hookworm and *trichuris*. Medical surveys con-

ducted earlier in this century are illustrative. For example, in a medical survey of 2354 Yapese in the early 1930s, 33.16 percent were infected with *ascaris*, 50.33 percent with hookworm, 98.91 percent with *trichuris* (Fujii, reproduced in Hunt et al. 1949; also see Lambert 1949). Of course, variation in the prevalence of helminthic infection occurs with differences in island ecology and local sanitation practices (Hainline 1965:262–263). Heavy helminthic infection, especially with hookworm, causes severe anemia, which can compromise advanced pregnancies and make births more risky for both mother and child (Lawson 1967; Lewis et al. 1973). Most importantly, a combination of hookworm infection and malaria places pregnant women at a substantial mortality risk and magnifies the fertility-limiting impact of both diseases (Groube 1993:174). Given the very high levels of hookworm infection noted by medical researchers on most islands in the Pacific earlier in this century (e.g., Lambert 1928; McKenzie 1925–1926), infection in some settings would have been sufficient to dampen fertility levels.

Filariasis

Filarial infection likely also dampened pre-Contact fertility on some islands. In the Pacific region the predominant species of filariasis is *Wuchereria bancrofti* (periodic form in Melanesia excepting the Loyalties and New Caledonia, nonperiodic elsewhere) (Inyengar 1965). *W. bancrofti* has involvement of the genital lymph vessels in both men and women, and consequently the greatest impact on population-level fertility of all the filarial species. Repeated attacks progressively damage the lymph vessels and may result in obstruction of the vessels with fibrosis so they cannot drain. In severe cases—where breast, vulva, scrotum, or penis becomes massive—essential acts of reproduction (coitus, childbirth, and breast feeding) become impossible. Also, the high fevers of the disease interfere with spermatogenesis and so can cause temporary male infertility (McFalls and McFalls 1984:134).

At best guess, filariasis entered Polynesia during human settlement of the region. The gross deformities of filariasis (elephantiasis) were observed throughout Polynesia by early European explorers, starting in Tonga by Tasman in 1643 (Laurence 1991). There are accounts of castration being used as a traditional ethnomedical response to testicular elephantiasis in New Caledonia, Tonga, and possibly Pohnpei (Hainline 1965:257; Lambert 1949:196; Laurence 1991), indicating an intimate familiarity with the condition. There appears to have been no pre-Contact filariasis in Hawai'i, the Marquesas, or the Cook Islands (Laurence 1991); all other islands were infected in the historic period, some with over 50–60 percent of adults (Bye et al. 1953; Inyengar 1965). Filariasis is transmitted by mosquitos, and the distribution and intensity of infection across the region is dependent on a suitable *Aedes* or (historically) *Culex* species. For example, the Tungaru (Gilbert) chain was free of the disease last century because of a lack of suitable mosquito vector, but cases started to appear after *Culex quinquefasciatus* was introduced (Lambert 1949:86; Wilkes 1856). In addition, low-lying coral atolls provide a more ideal environment for repeated infection, as maintained contact with mosquitoes allows hyperinfection and increases the risk of elephantiasis (Inyengar 1965). In such cases, filarial infection dampens fertility, although the impact is subdued.

POPULATION REGULATION BEFORE AND AFTER EUROPEAN CONTACT

Population-limiting behaviors provide a potentially vital adaptation to limited island ecologies, and most flexible (and so most crucial) are those that allow adjustments in fertility. The growth-to-stasis model of Pacific prehistoric population change invokes these mechanisms as central, but specifically to the stasis phase. For example, in Polynesia:

colonizing propagules were small . . . [and had a] reproductive strategy emphasizing fecundity and a high intrinsic growth rate [but] . . . by the time of European intrusion, all of these island societies had reached relatively high density levels with density-dependent cultural controls on population growth (including abortion, infanticide, celibacy, and other forms of overt competition). (Kirch and Green 1987: 442)

Although evidence of such limiting behaviors cannot be derived directly from the archaeological record, historic archival evidence is rich. There are two effective and direct population control devices that were widely used in Pacific island groups through the early historic period: infanticide and induced abortion, as indicated in European observers' reports. The historic archival reports are necessarily biased, overstating and often misinterpreting antifertility behavior. Nonetheless, reports of infanticide are widespread and reasonably consistent.¹⁰ They show that infanticide was more common than abortion at European contact in the Pacific, and therefore more common in the late pre-Contact setting by implication, but essentially disappeared with increasing European contact. Seemingly effective massage methods of induced abortion (Sarker 1981) are mentioned for virtually every group in the island Pacific in the historic literature (with the notable exception of New Zealand), although much less commonly in the earliest European accounts. As I have argued in more detail elsewhere (Brewis 1990), the growing popularity of induced abortion as a birth-limiting device through the historic period follows European efforts and success at eradicating infanticide on many islands (also Krzywicki 1934: 187), although the exact nature of this transition remains to be properly explained; it is more than simply a case of "method switching."

The implication is clear, though. Post-Contact accounts represent the continuation (albeit transformed) of adaptive behavioral mechanisms instituted (or re-instituted) during (or at the beginning of) pre-Contact sequences that were adaptations intimately linking population dynamics to ecological ones. These adaptations were as valuable in historical demographic-ecological contexts as were prehistoric ones (although for different reasons, perhaps). Certainly, in this sense, archival data sources have been underused (although not ignored; see Kirch 1984: 116–120). However, until we better understand how such overt practices as infanticide and abortion played out broader ecological, behavioral, demographic, and sociocultural contexts within island settings in the region (for example, how they are integrated into ethnomedical systems), the connections remain speculative at best.

CONCLUSION

The answer to the question of "What are the best analogies of settling, growing, and collapsing pre-Contact Pacific populations?" the range of fertility profiles

from the region show (not surprisingly) that no such epitomes exist. Rather, it is the dramatic range of demographic expression seen in these historical and contemporary examples that provides some of the best clues about pre-Contact population. According to an ecological-demographic view (such as described by Pietrusewsky 1990; Underwood 1989b, 1990a), Pacific palaeopopulations were accustomed to, and so adapted to, recurrent flux in population numbers on the one hand (whether as a result of frequent but unpredictable catastrophe or the bottlenecking process of colonization and settlement), and the problems of dealing with rapid growth and population expansion and increasing density in limited and fragile ecologies on the other. The historical-contemporary demographics of many populations in the region show exactly these two different processes, albeit writ broad and sequentially reordered. On the basis of the disease evidence, high fertility was possible and maintainable in both early and late sequence populations, compared to lowered fertility in contact groups infected with gonorrhea. This view sits comfortably with the notion of a "Pacific island pattern" of reproduction, one that emphasizes maximization of fertility across the reproductive span and marriage cycle (Brewis 1993a, 1993b; Underwood 1990b, 1993).

If this perspective of a closer tie between the macrodemographic responses of the historical and pre-Contact period is reasonable, then it becomes evident that rural contemporary and historical reconstructive demographic studies of Pacific island populations provide rich sources of information about pre-Contact population dynamics and context. Demographic investigations from the region describe a wide variety of scenarios—of growth, collapse, stable change, and perturbation. The use of analogies provides a dramatic and illustrative range of fertility experiences, for example, related to a wide range of factors—disease, marriage patterns, fertility-regulating behavior, and so on. For example, one implication of examining fertility scenarios across time and space in the region is that it aids an understanding of the relationship between the seemingly rapid speed of prehistoric population expansion—both geographic and numerical—into and through Polynesia (see Irwin 1992) and ecological/geographic differences in endemic fertility-suppressing disease in Near versus Remote Oceania. Groube (1993), in discussing malaria, provides some interesting insights, but the explicit demographic sequelae remain to be stated. To be specific: the move into malaria-free zones, and the associated removal of the fertility-dampening effect of malarial morbidity (and the synergistic effect of hookworm infestation on exacerbating the symptoms of malaria morbidity), would have been sufficient to spur a crucial change in population growth rates and hence numerical and geographic expansion of ancestral Polynesians. This is neither specifically a density-dependent or independent relationship: rather, as is the case with complex biocultural phenomena, both are implicated.

Another implication is for a better understanding of how, when, and if pre-Contact populations invented, reinvented, borrowed, and used methods of internal population regulation, and how this related to a complex, fluxed population history, albeit one that reflected the ultimate evolutionary badge of success: growth, *in both prehistoric and historic settings*. Although Kirch (1984: 108) suggests "an absence of density-dependent controls should characterize colonizing propagules," this does not appear to have been the pattern exemplified in the historic populations that became the founding propagules in that portion of Pacific popu-

lation history—those populations that suffered massive depopulation but went on to demographic recovery and expansion. Those populations had fertility-limiting repertoires. The implication here is that successful founding propagules in the Pacific are not dependent on an absence of fertility-limiting repertoires.

This paper aims to be suggestive rather than specific about such implications, pointing out the potential values of historical analogy. It is in fine-grained, ethnographically informed investigations of the ecological dimensions of contemporary and “ethnographically present” Polynesian populations that the complexities and macropatterning of island demography can be seen in their full color and expressional variety. Such studies have much to offer to a more vital demographic prehistory of the region. One criterion for analogical reasoning in this field is the use of populations that are well described in the fullest human ecological, epidemiological, and historic sense.

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NOTES

1. Improved understanding of the nature of heterogeneity of frailty in populations also challenges palaeopathological inferences about population levels of morbidity. This is, as Wood et al. (1992) describe it, because of the “osteological paradox,” where the individuals with the least healthy palaeopathological profiles may in fact be those who survived insults long enough to show the bony evidence of their impact. Thus, “better health makes for worse skeletons.” Although this provides a frustrating block to palaeopathological enquiry in the Pacific, it may solve the mystery of why essentially “healthy” pre-Contact islanders appeared to have such short lives.
2. At this point, I avoid a distinction between analogy and homology, even though in an evolutionary sense the distinction between the two is crucial. Rather, I use the term “analogy” to refer loosely to both.
3. Interestingly though, Kirch (1992:171) and Graves and Ladefoged (1991) have more recently argued that the population of Hawai‘i, in parts of the archipelago at least, was growing at Contact.
4. Genealogical reconstruction may be the least reliable of these methods, as it will depress fertility estimates if infertile women are “forgotten” (Norton 1980). However, in the cases included in this sample, primary infertility rates were high enough that this is not a substantial problem.
5. Campbell and Wood (1988) employ a minimum-sample-size criterion of 50 postmenopausal women. Here a cutoff of 45 is employed, because several of the surveys had sample sizes just short of 50.
6. Although Pitcairn was anomalous in origin, structure, and genetic makeup, it is included for comparative purposes.
7. Information on the presence of specific diseases in the different populations needs to be treated with caution, however, as reports may misidentify or misreport levels of various diseases, and sometimes reports for the same period give conflicting accounts. Estimates of the level of gonorrhea refer to the period in which sampled women were reproducing, as noted with CFS measures.
8. I have avoided discussion of syphilis, another fertility-inhibiting disease, because yaws—endemic through the tropical Pacific in prehistory—provides cross-immunity to syphilis, and the two may constitute a single disease entity (Merbs 1992). Yaws has no impact on reproductive function in either men or women.

9. To enhance comparability, only populations where primary infertility rates are under 15 percent are included, as this was an inclusion criterion in the CW global sample. Note that the CW global sample includes three of the Pacific groups (Ontong Java, Makin, Karkar).
10. For example, infanticide was noted in New Britain (Parkinson 1907), Vanuatu (Glaumond 1889; MacDonald 1892), Solomon Islands (Elton 1888; Guppy 1887), Tikopia (Rivers 1914), Ontong Java (Bayliss-Smith 1975:419), Fiji (Wilkes 1856), Nukuoro and Samoa (Meinicke 1876), Niue (Thomson 1908), Rarotonga (Gill 1885), Tahiti (Ellis 1853; Lutteroth 1843), Marquesas (Hale 1846), New Zealand (Brown, G. 1910), Tuvalu (Edgeworth David 1899; Murray 1876), Kiribati (Turner 1884), the Marianas (Kotzebue 1821), and the Carolines (Born 1907). Societies argued to be infanticide-free in this same time frame include Yap (Salesius 1907; cited in Devereux 1955), Samoa (Turner 1884), and Tonga (West 1865). The historical literature is voluminous, and this list represents only a sampling.

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ABSTRACT

Understanding the palaeodemography of Pacific populations is fundamental to interpreting biological and cultural transformations in pre-Contact Pacific island societies, but skeletally based reconstructions of past demography are of questionable utility. This paper argues that the use of historic and contemporary population studies, which describe the dynamic of population change in ecological context, offers a particularly rich, but often ignored, source of material for palaeodemographic inference. Reasons for this underutilization include the notion that prehistoric and historic populations on islands were essentially dissimilar in structure and mode of change, most particularly that pre-Contact populations grew and had high fertility whereas post-Contact populations collapsed and were uniquely infected with fertility-inhibiting diseases. An examination of the available case studies shows that, on the contrary, there is no such clear dynamic that describes these ethnographically situated cases, except for a tendency to recover—often effectively—from population collapse. Rather, structural similarities between pre-European and historic demographies allow analogies to be drawn backwards, providing an under-used means for examining the ecological and behavioral correlates and tempo of population expansion, the nature of responses to population collapse, and repertoires of internal population regulation in Pacific prehistory. KEYWORDS: palaeodemography, fertility, Pacific islands.